# Predation of Juvenile Salmon by Littoral Fishes in the Lake Washington-Lake Union Ship Canal, Preliminary Results.

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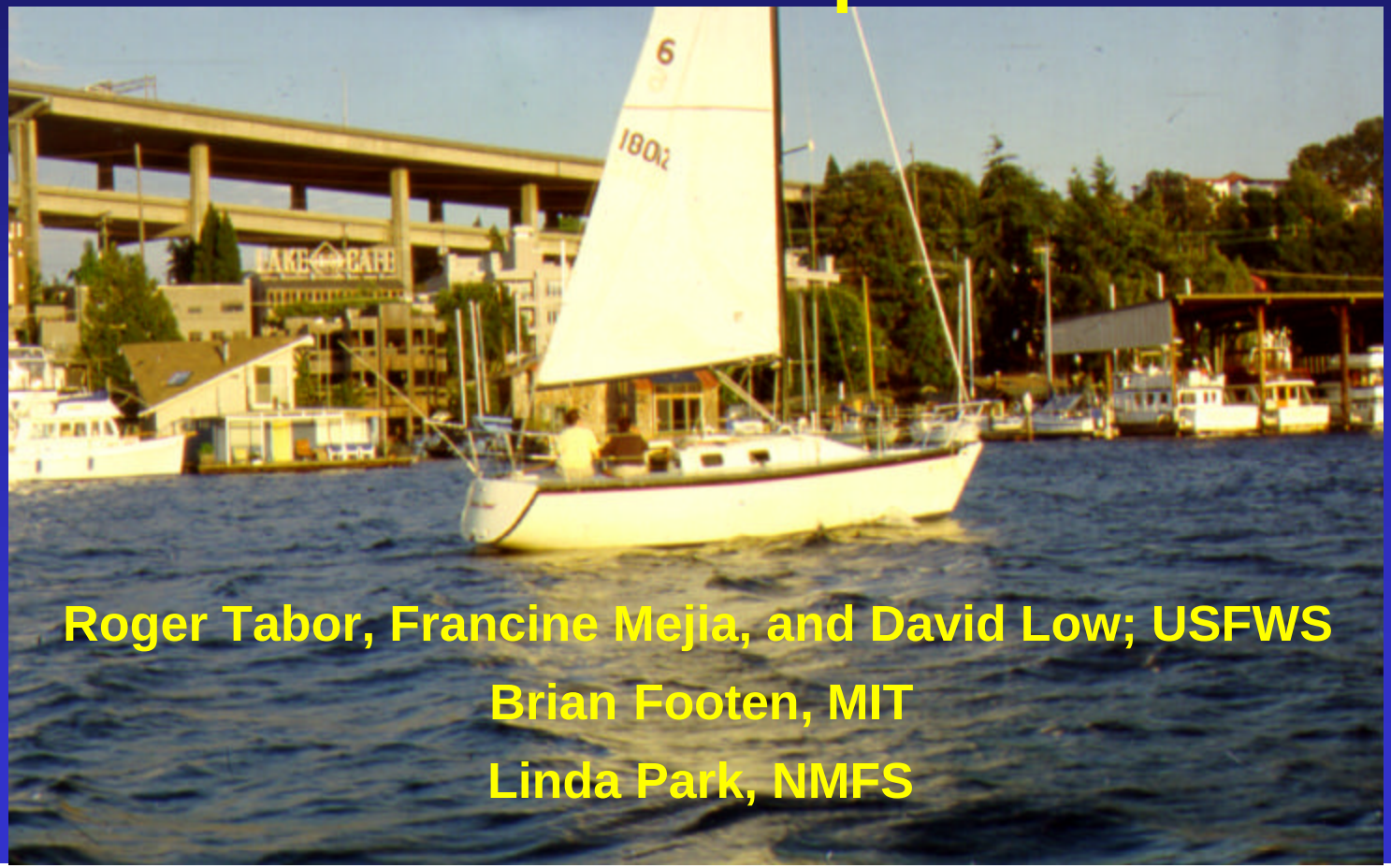
In the Lake Washington basin, salmonid smolts must migrate through the Lake Washington-Lake Union Ship Canal and pass through the Ballard Locks before they reach saltwater. Within the Ship Canal, smolts are vulnerable to several species of predatory fishes including, northern pikeminnow (*Ptychocheilus oregonensis*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*M. salmoides*). Preliminary research done by the Muckleshoot Indian Tribe, U.S. Fish and Wildlife Service, and University of Washington in 1995 and 1997 indicated that smallmouth bass may be an important predator of salmonid smolts in the Ship Canal. Sampling was limited to a few dates and many areas of the Ship Canal had not been sampled. In 1999, we conducted a more intensive study to determine the overall consumption of smolts by littoral predators in the Ship Canal.

Fish were collected at night with boat electrofishing equipment. Stomach contents were removed and fish were tagged for a mark-recapture population estimate. Catch rates of northern pikeminnow were low in comparison to bass. This may be due to their vulnerability to shoreline electrofishing. In other systems, northern pikeminnow appear to inhabit deeper waters than bass. From the end of April to the end of July, we removed the stomach contents of over 900 predators. Consumption of smolts was observed in both bass species and northern pikeminnow from mid-May to the end of July. Predators were collected throughout the sample area, however, few predators were collected in Salmon Bay.

Smallmouth bass of all size categories consumed smolts. The smallest smallmouth bass observed to have consumed a smolt was 138 mm FL (fork length). Predation appeared to be highest in June, when smolts made up approximately 50% of their diet. Consumption rates of smolts by largemouth bass were generally low. Predation was only observed in fish 148-249 mm FL. Approximately 45% of the diet of northern pikeminnow consisted of smolts. Identification of smolts was done visually (freshly ingested smolts) or through genetic analysis (well-digested smolts). Thus far, we have identified 20% of all ingested smolts to species. Of those, 56% were chinook salmon smolts. The remainder were coho salmon (27%) and sockeye salmon (17%) smolts. Results of ongoing genetic analysis of the unidentified smolts will provide a more accurate picture of predation of chinook smolts.

Population estimates were done for smallmouth bass and largemouth bass but not northern pikeminnow. We estimated there were approximately 3,400 smallmouth bass and 2,500 largemouth bass in the Ship Canal. Estimates were made for fish that were > 130 mm FL which should include all fish that may consume smolts. A bioenergetics model was used to estimate total consumption of smolts The highest consumption occurred in the age 2 fish because of their large population size and high growth rates. Most predation occurred in Portage Bay. A preliminary estimate of the number of smolts consumed was based on the average original weight of smolts observed in the stomach samples, 9.4 g. We estimated that smallmouth bass consumed approximately 48,000 smolts and largemouth bass consumed 4,200 smolts. Once genetic analysis is completed, consumption estimates will be recalculated. Further analyses will also include direct consumption estimates.

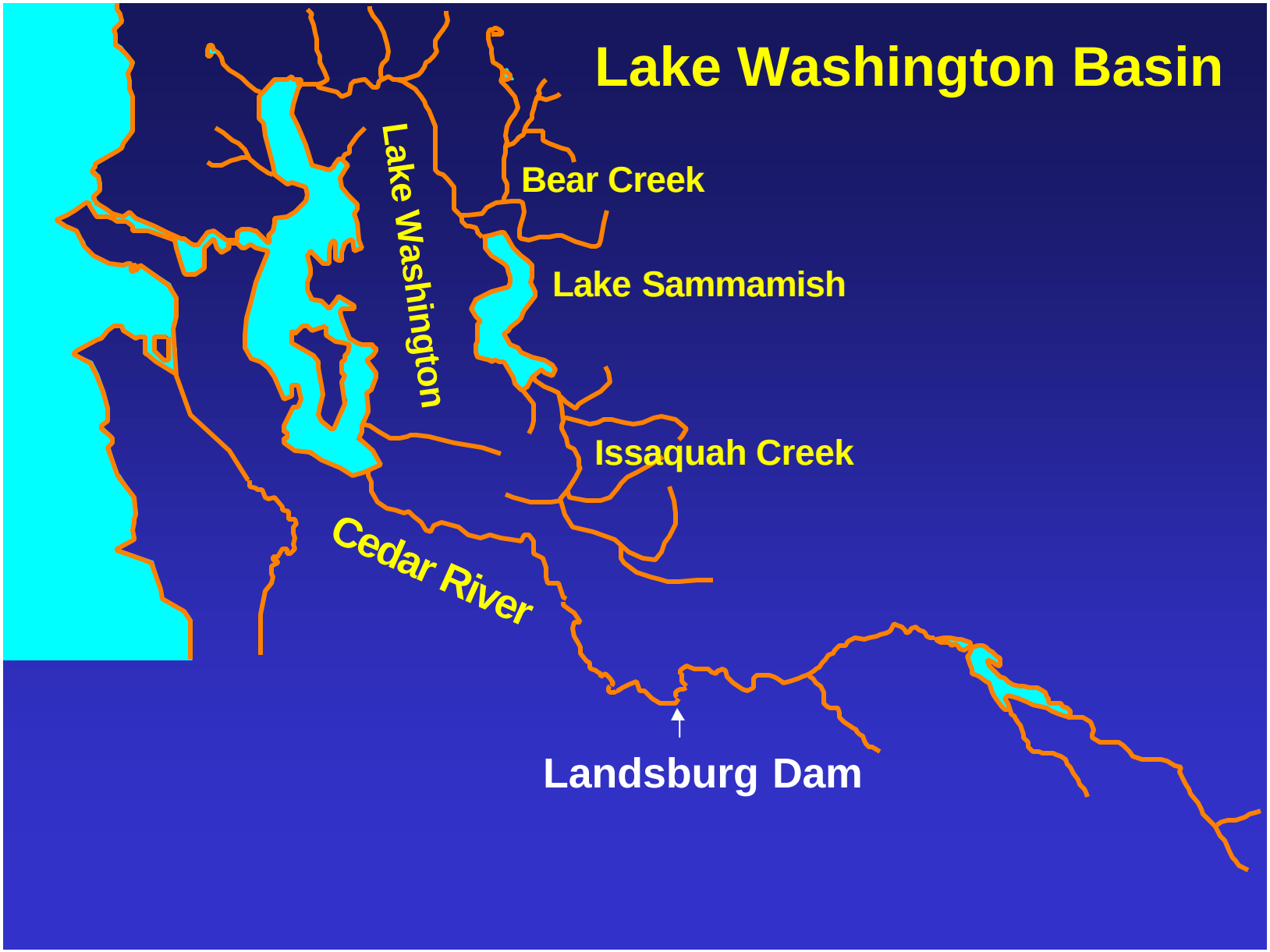
# Predation of juvenile salmon by littoral fishes in the Lake Washington-Lake Union Ship Canal

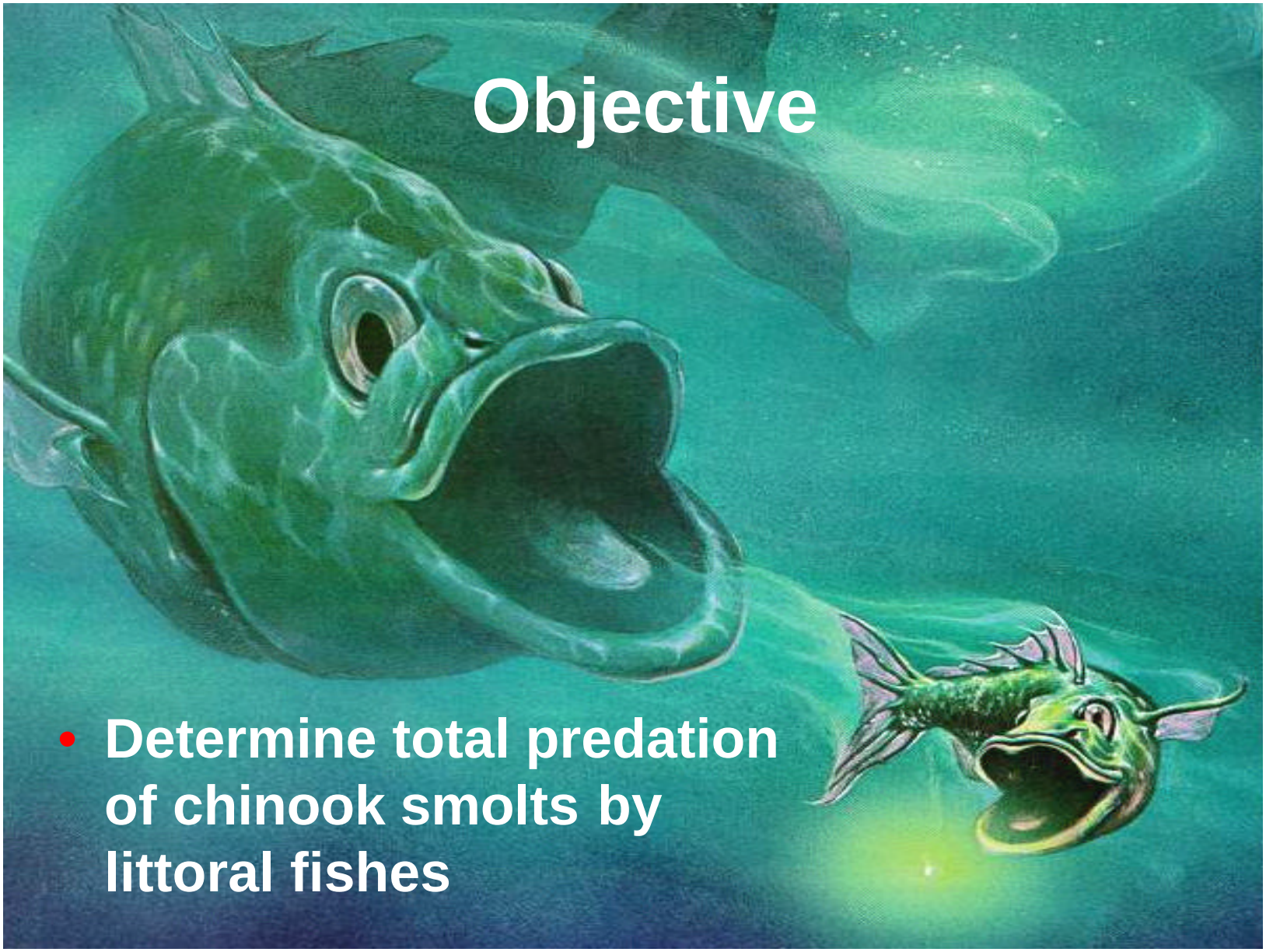


Roger Tabor, Francine Mejia, and David Low; USFWS

Brian Footen, MIT

Linda Park, NMFS


Lake Washington Basin
Lake Washington
Bear Creek
Lake Sammamish
Issaquah Creek
Cedar River
Landsburg Dam


Objective
• Determine total predation of chinook smolts by littoral fishes

# Objectives

- Estimate population sizes
- Sample during entire outmigration period
- Sample all areas in Ship Canal
- Determine species of ingested smolts

# Potential Fish Predators of Smolts

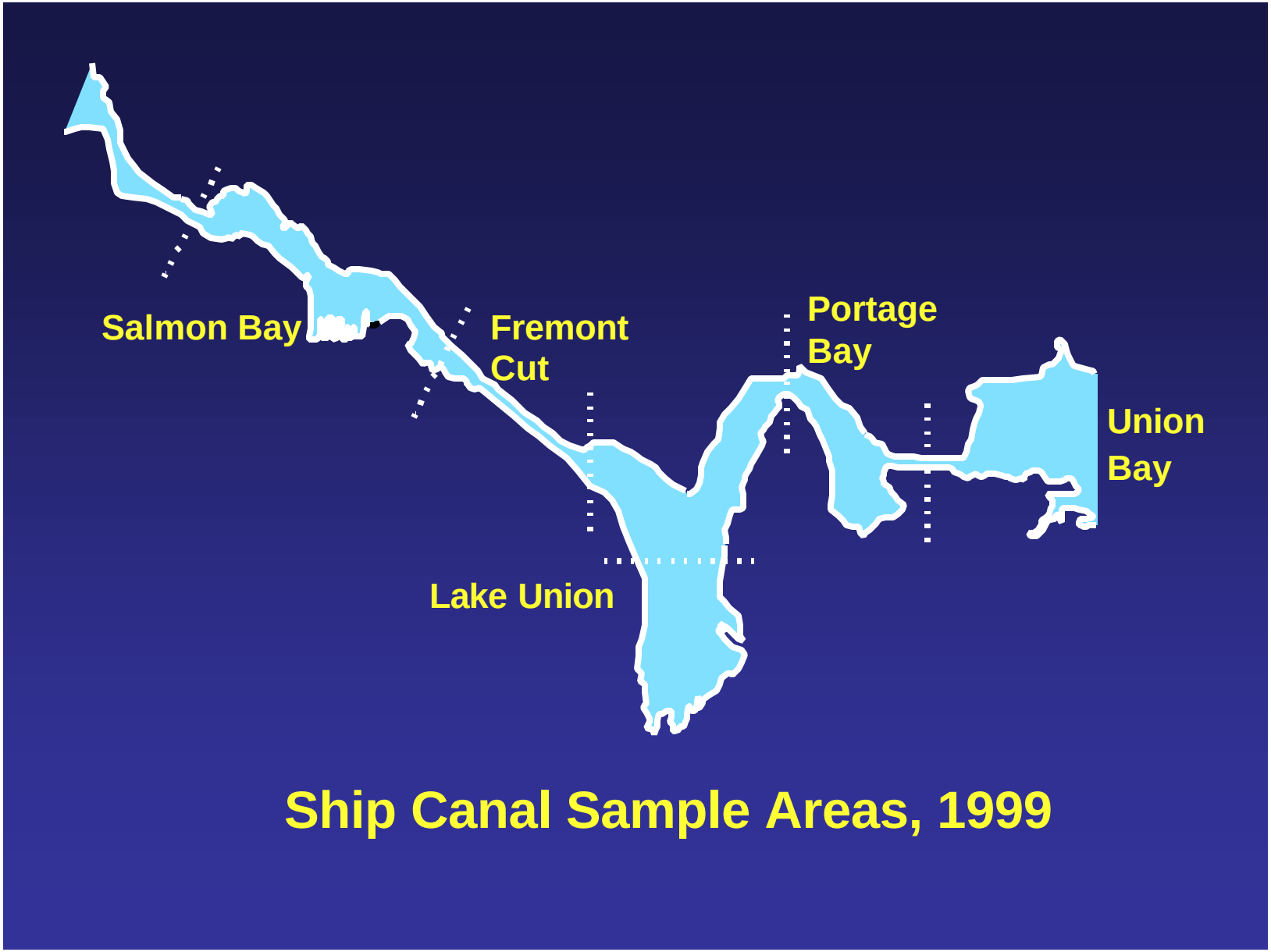
- **Introduced Fish**
  - Smallmouth bass
  - Largemouth bass
  - Yellow perch
  - Brown bullhead
- **Native fish**
  - Northern pikeminnow
  - Cutthroat trout
  - Rainbow trout/Steelhead
  - Prickly sculpin
  - Coho salmon
  - Bull trout

# Methodology

- Night boat electrofishing along 500-m transects
- 2-3 transects for each area per sampling date
- Sampled from late-April to the end of July
- April-May sampled once every two weeks; June-July sampled once a week

# Methodology

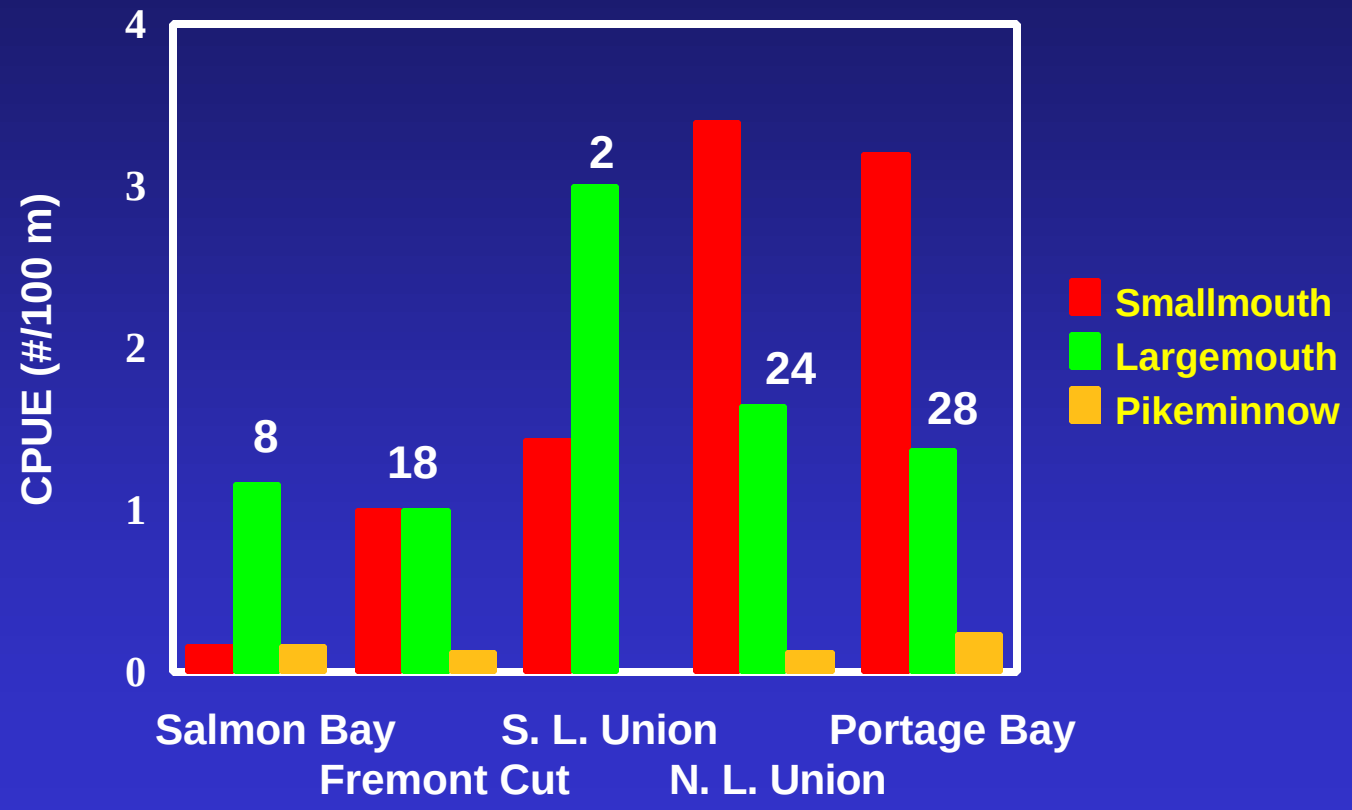
- Small Floy tags used for mark-recapture
- Scales removed for age and growth analysis
- Stomach contents removed
  - Diet analysis
  - Little-digested smolts identified visually
  - Well-digested smolts identified with DNA analysis (L. Park, NMFS)

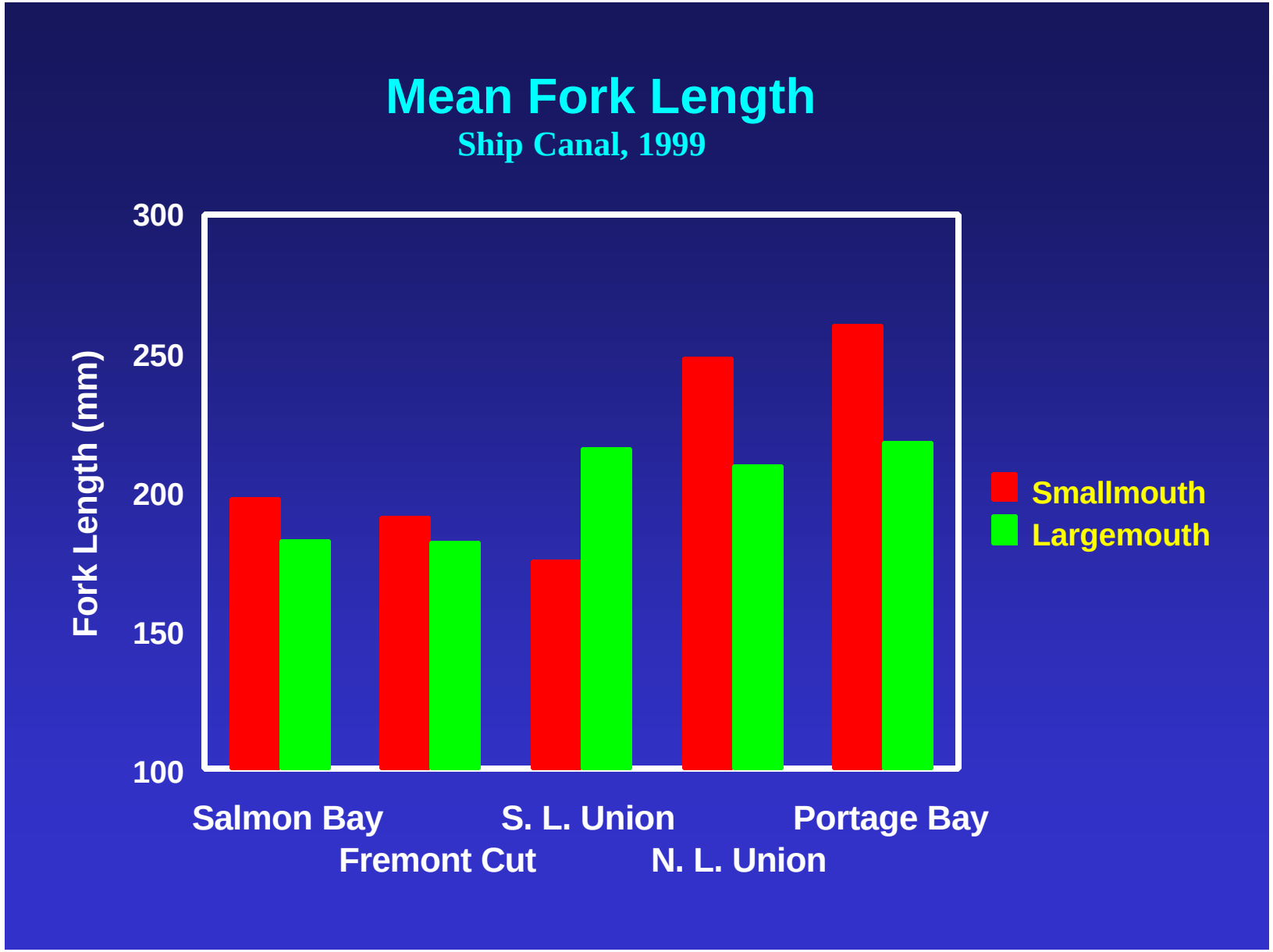



# Ship Canal Sample Areas, 1999

# Catch Rates

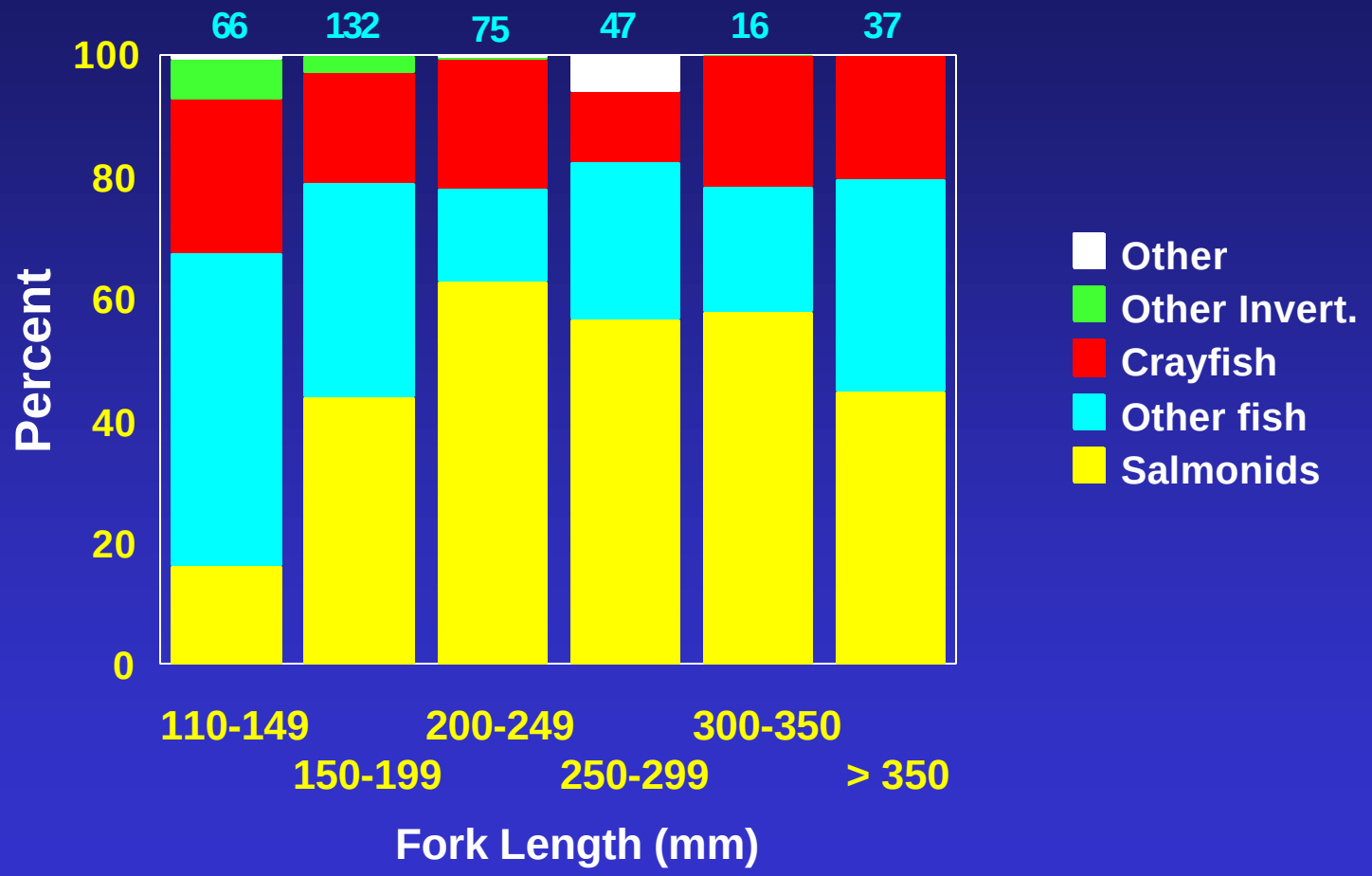
## Adjusted by shoreline sampled




Mean Fork Length
Ship Canal, 1999
Fork Length (mm)
300
250
200
150
100
Salmon Bay
Fremont Cut
S. L. Union
N. L. Union
Portage Bay
Smallmouth
Largemouth

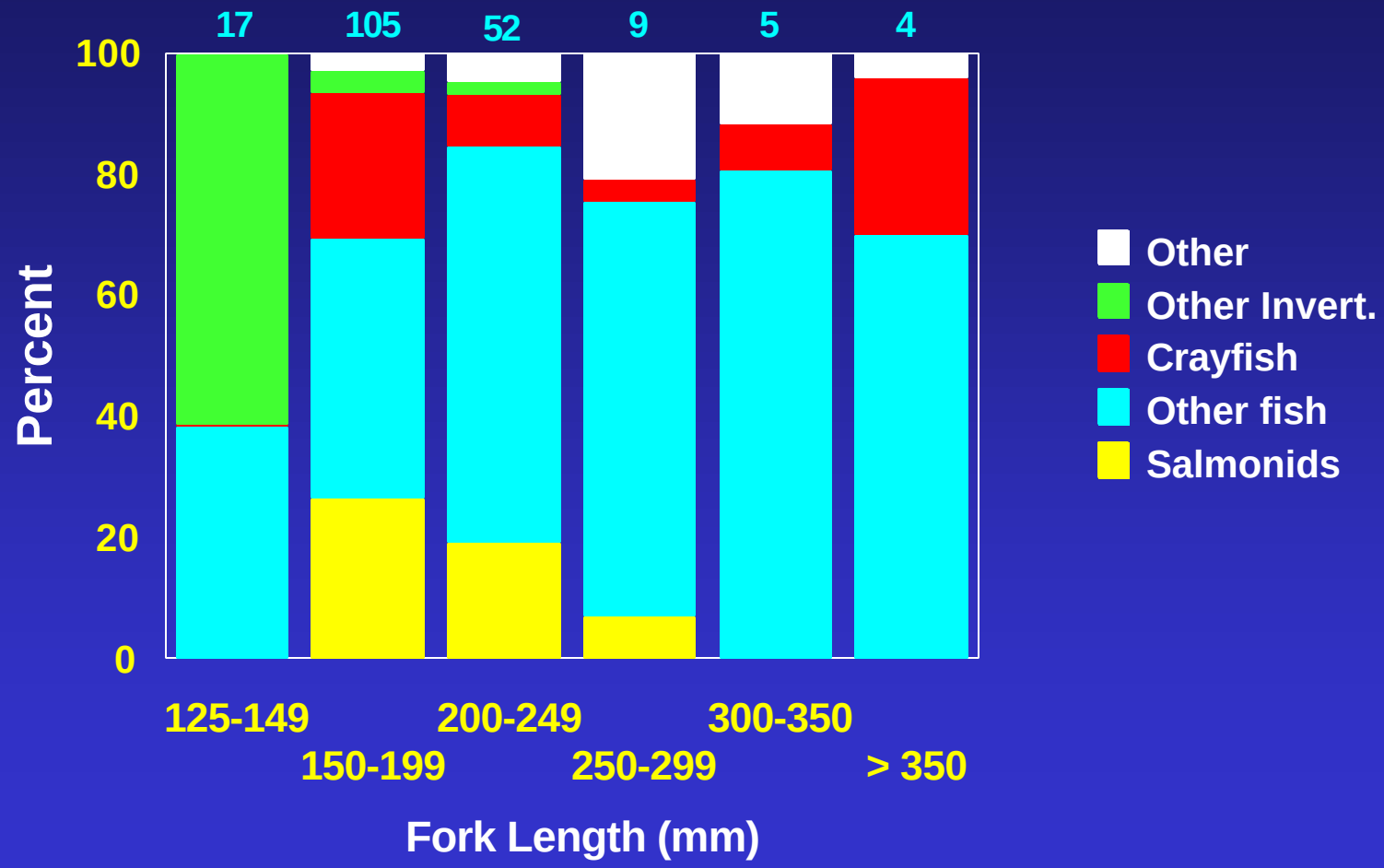
# Smallmouth Bass Diet

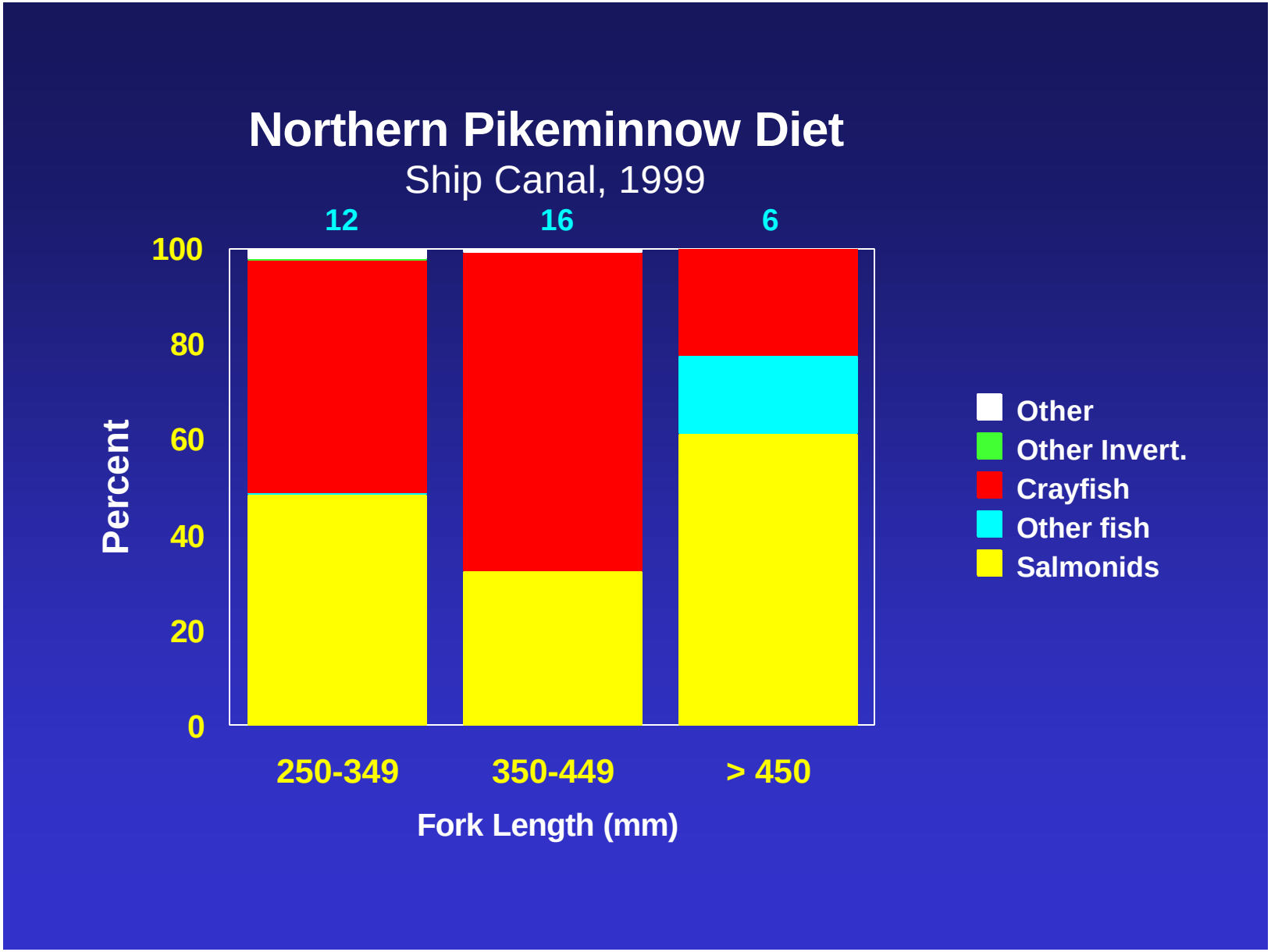
Ship Canal, 1999



# Largemouth Bass Diet

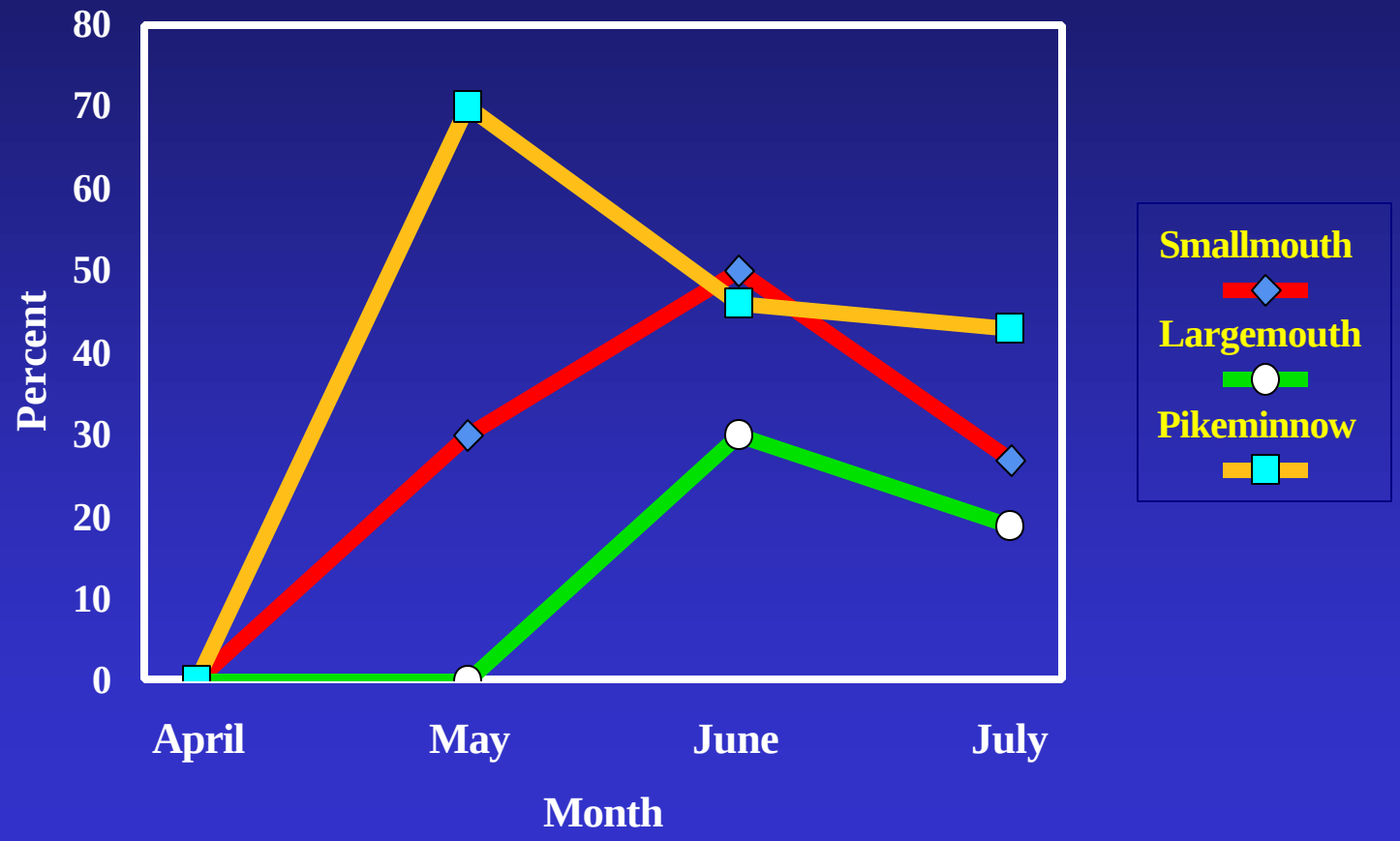
Ship Canal, 1999



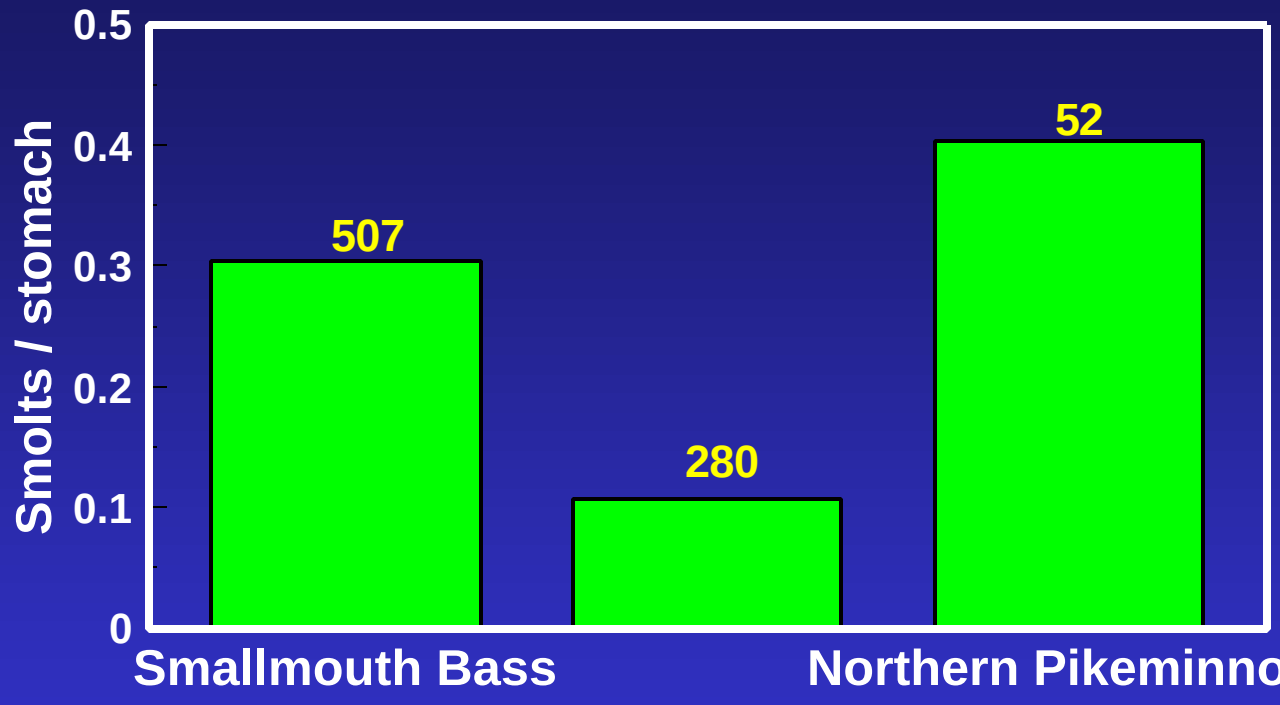

Northern Pikeminnow Diet
Ship Canal, 1999
12
16
6
100
80
60
40
20
0
Percent
250-349
350-449
> 450
Fork Length (mm)
Other
Other Invert.
Crayfish
Other fish
Salmonids

# Percent of Diet composed of Salmonids

## Ship Canal, 1999



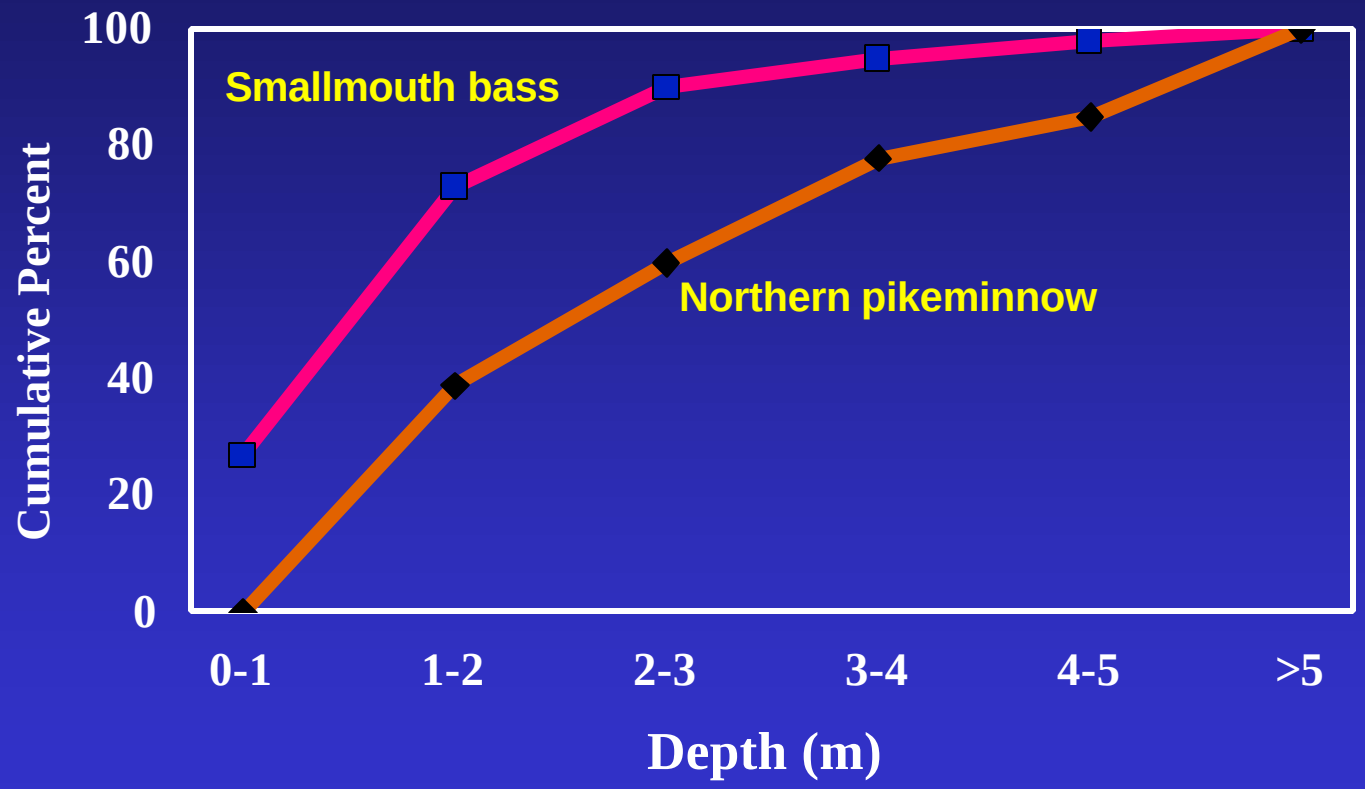
## Consumption of Smolts, April-July, 1999



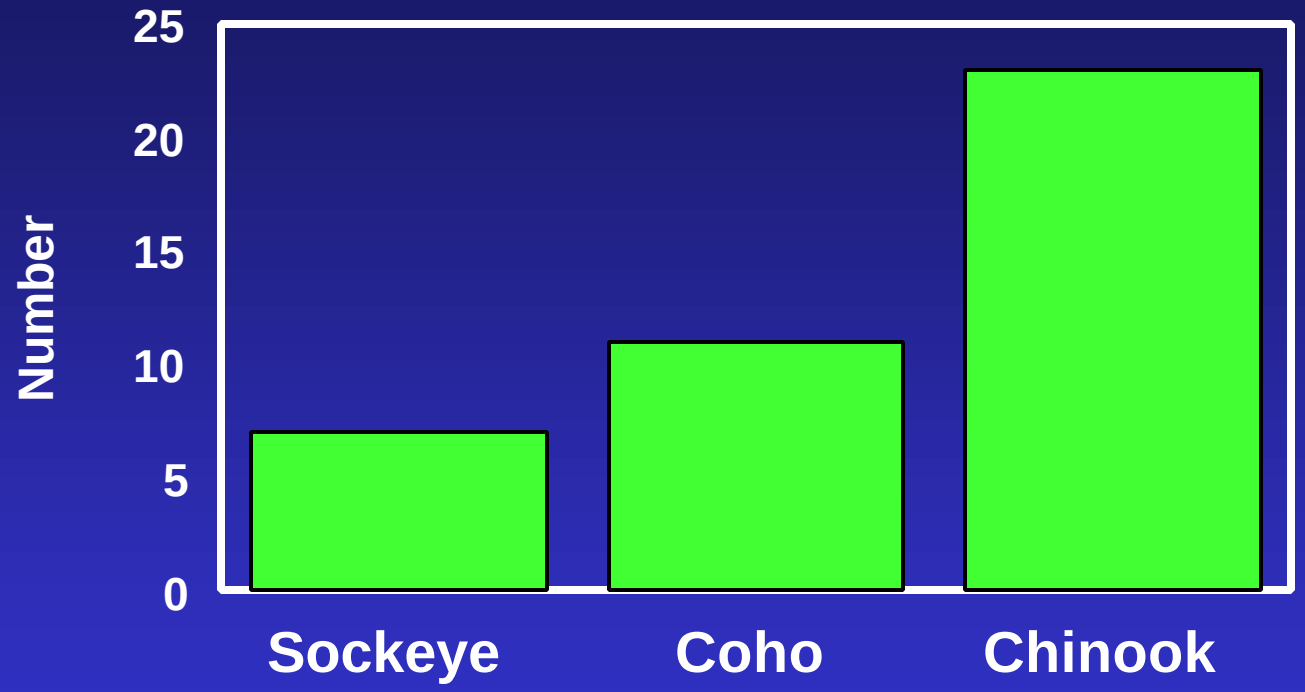

**Other species:**
**Cutthroat trout - 50**
**Brown bullhead - 22**

# Depth Selection

## Columbia and Snake Rivers, USGS, J. Petersen et al. 1999



# Salmonid Species Consumed




Note: 41 (20%) smolts identified

168 (80%) smolts left unidentified

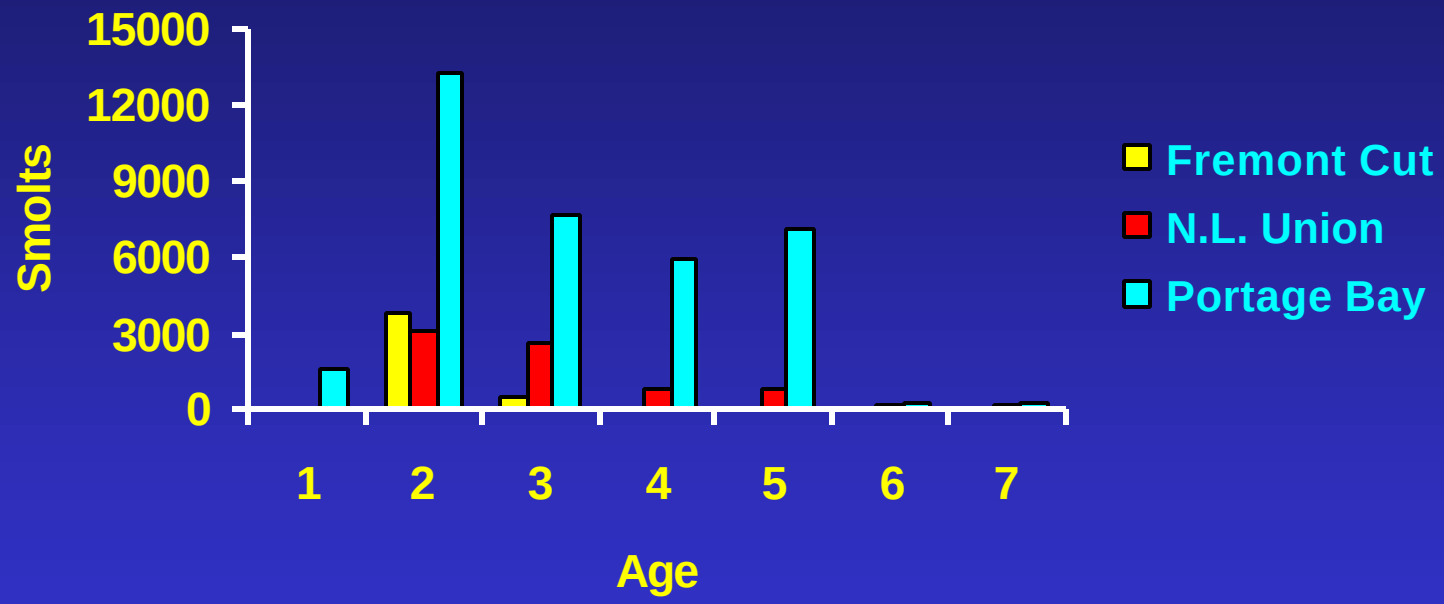
# Population estimates

- Multiple-census estimate for age 2 and older fish
- Adjusted for areas not fished
- Adjusted for large age 1 fish
- Home range assumed to be 0.5-2 km

# Population estimates

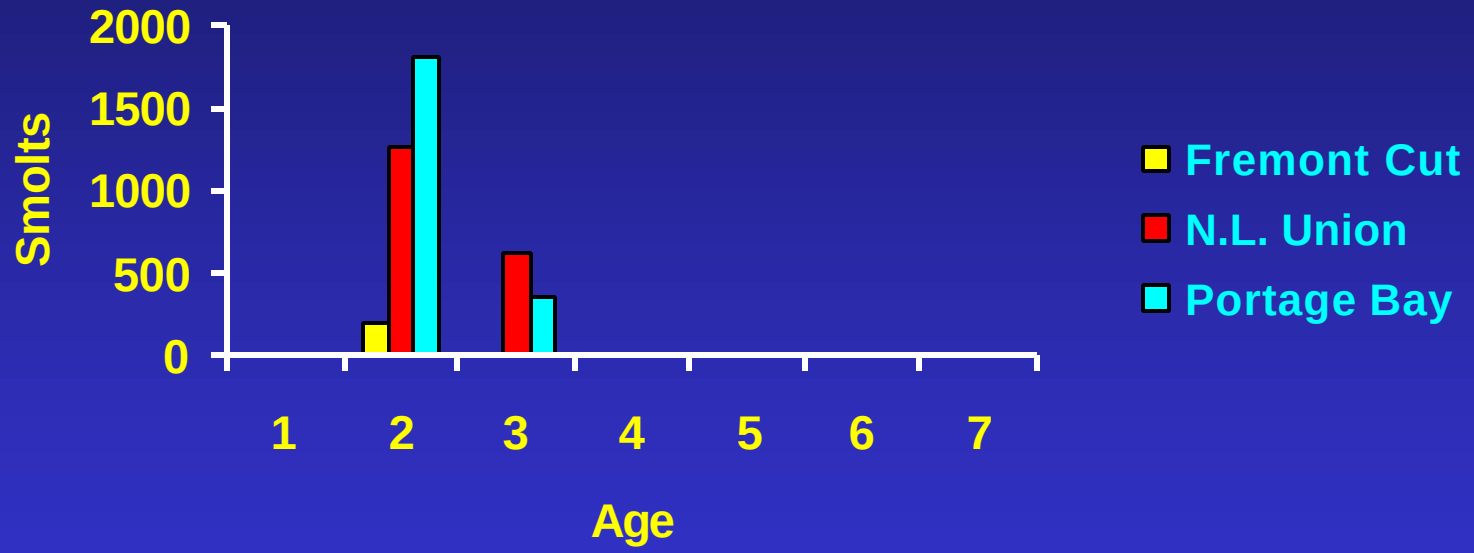
| | Smallmouth | Largemouth |
|---|---|---|
| Salmon Bay* | 95 | 507 |
| Fremont Cut | 370 | 213 |
| S. Lake Union* | 426 | 676 |
| N. Lake Union | 555 | 642 |
| Portage Bay | 1941 | 461 |
| Total | 3387 | 2499 |

## Smallmouth Bass Predation




**Total = 47,817**

## Largemouth Bass Predation




**Total = 4,235**

# Conclusions

- Smallmouth bass consumed large numbers of smolts
- Largemouth bass consumed smolts but predation rates were far lower than smallmouth bass
- Pikeminnow appear to be an important predator but little data is available on their population size

# Conclusions

- **Chinook salmon were the main salmonid species consumed**
- **Consumption of smolts occurred primarily from mid-May to the end of July**

# Further Analyses

- DNA analysis
- Bioenergetics model
- Direct consumption model